



⑫

## EUROPEAN PATENT APPLICATION

⑬ Application number: 94302776.3

⑮ Int. Cl.<sup>5</sup>: H04N 7/173

⑭ Date of filing: 20.04.94

⑯ Priority: 03.05.93 US 56973

⑰ Date of publication of application: 09.11.94 Bulletin 94/45

⑲ Designated Contracting States: DE ES FR GB IT

⑳ Applicant: AT & T Corp.  
32 Avenue of the Americas  
New York, NY 10013-2412 (US)

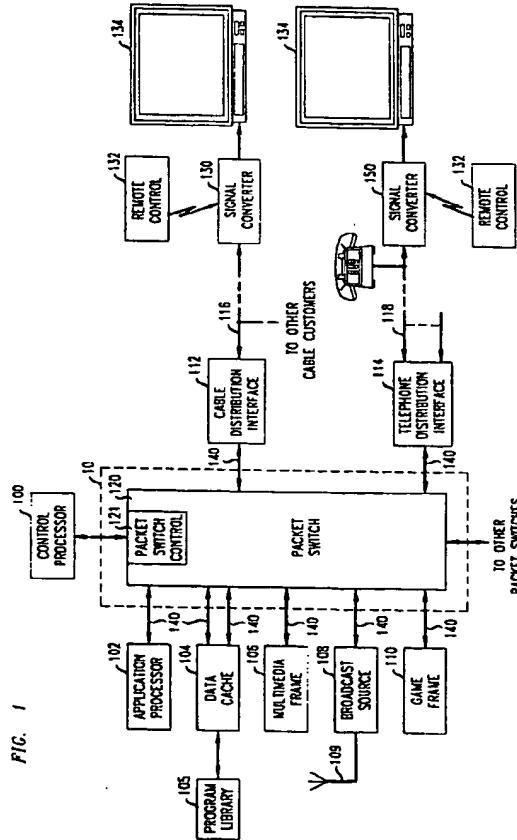
⑷ Inventor: Blahut, Donald Edgar

9 Stevens Drive  
Holmdel, New Jersey 07733 (US)  
Inventor: Szurkowski, Edward Stanley  
9 Collinwood Road  
Maplewood, New Jersey 07040 (US)

⑵ Representative: Buckley, Christopher Simon  
Thirsk et al  
AT&T (UK) LTD.,  
AT&T Intellectual Property Division,  
5 Mornington Road  
Woodford Green, Essex IG8 0TU (GB)

### ④ Integrated television services system.

⑤ A system is disclosed for delivering audio and/or video signals to users in connection with the provision of interactive television services. Various sources of such signals are connected to a digital network (10), such as a packet network. Also connected to such network are control (100) and application (102) processors and interfaces (112,114) to distribution arrangements such as cable television systems (116) and telephone subscriber loops (118). Each user has a signal converter (130,150) for receiving a digital signal from the distribution arrangement, converting such signal for viewing on a conventional television receiver (134) and transmitting control packets to other elements of the system. The signal sources can include a data cache (104) for storing recorded video and audio materials, a broadcast source (108) for receiving broadcast signals, apparatus (106) for composing multimedia signals from multiple sources, and apparatus (110) for running games. The various elements of the system can be situated at different geographical locations and operated by the control and/or application processors (100,102) under software control to provide a variety of interactive television services.



**Technical Field**

This invention relates to interactive television systems, and more particularly to systems for providing a variety of interactive television services to users via distribution systems such as cable television systems or telephone networks.

**Background of the Invention**

Cable television systems have made possible the transmission of many channels of television programs to the homes of subscribers. Instead of being limited to the number of VHF and UHF channels that can be transmitted and received in a given area, the number of channels in cable systems is limited only by the transmission characteristics of the cable itself and the ability to compress the information in television programs into narrower-bandwidth channels. The advent of fiber-optic transmission systems for use in cable television networks has also vastly increased the number of channels available.

Such increase in channels has also given rise to proposals for interactive television systems wherein a subscriber can transmit information or requests back into the system, which information or requests may subsequently affect programs or information directed to such subscriber. There are a wide variety of applications for interactive television systems, such as video games, video catalog shopping, teaching systems, movies on demand and audio programs. Each application can be tailored for an individual subscriber, for example a subscriber may be able to select the language of the soundtrack in a movie. However, such systems typically require the ability (i) to control specific programs or information sent to each subscriber and (ii) to receive input messages or requests from the subscriber.

A headend-to-subscriber channel does not need the full bandwidth of the usual television cable channel if compression can be used. For example, if a television signal is digitized and compressed in accordance with the MPEG standard, it is possible to transmit sixteen television programs digitally over a single conventional 6 MHz cable channel. Other program information, such as high-fidelity audio, still video pictures or text can also be sent in compressed form. By using a large number of conventional channels for ITV purposes, such as is now possible with optical fiber distribution systems, together with compression, it is conceivable that hundreds of virtual channels could be made available.

Systems are also becoming available for transmitting compressed and encoded television signals over telephone circuits. In one such system, 1.5 megabits/second of data, sufficient for one compressed and encoded television channel, can be transmitted from a telephone central office over a twisted-pair

loop to a subscriber's premises, and 16 kilobits of data can be transmitted back to the central office, together with regular telephone service. Such a loop is known as an asymmetric digital subscriber loop.

With the wide deployment of digital communication systems, standardized digital transmission systems have become available in which data is transmitted in packet form over networks. One such network is an asynchronous transmission mode (ATM) network in which packets of varying length can be sent. Such packet networks can be used for carrying digitized television signals.

Clearly the means now exist by which tailored television signals can be delivered to individual users, such as by cable television systems, telephone networks, packet networks and satellites. Also, a large number of sources are available from which programs and interactive television applications can be provided. However, problems arise in interconnecting and controlling all the possible signal sources and means of delivery needed to provide interactive television services in a flexible and efficient manner.

**Summary of the Invention**

A system is disclosed for delivering audio and/or video signals to users in connection with the provision of interactive television services. Various sources of such signals are connected to a digital network, such as a packet network. Also connected to such network are control and application processors and interfaces to distribution arrangements such as cable television systems and telephone subscriber loops. Each user has a signal converter for receiving a digital signal from the distribution arrangement, converting such signal for viewing on a conventional television receiver and transmitting control packets to other elements of the system.

The signal sources can include a data cache for storing recorded video and audio materials, a broadcast source for receiving broadcast signals, apparatus for composing multimedia signals from multiple sources and apparatus for running games. The various elements of the system can be situated at different geographical locations and operated by the control and/or application processors under software control to provide a variety of interactive television services.

These and other aspects of the invention will become apparent from the drawings and detailed description.

**Brief Description of the Drawing**

FIG. 1 is an overall block diagram of an integrated television services system configured in accordance with the invention.

FIG. 2 is a block diagram showing the overall flow

of control and data packets in a system configured in accordance with the invention.

FIG. 3 is a block diagram of an interface for distributing integrated television services over a cable television system.

FIG. 4 is a block diagram of a signal converter for use by a cable television system customer.

FIG. 5 is a block diagram of an interface for distributing integrated television services over telephone subscriber loops.

FIG. 6 is a block diagram of a signal converter for use by a telephone subscriber.

FIG. 7 is a diagram of a menu screens used that can be displayed by the system of the invention.

FIG. 8 is a flow chart showing the operation of the invention in selecting and showing a movie.

### **Detailed Description**

FIG. 1 is an overall block diagram of a basic integrated television services system configured in accordance with the invention. The elements of the system communicate through packet network 10, which includes one or more packet switches 120. Such elements include control processor 100, application processor 102, application resources such as data cache 104, multimedia frame 106, broadcast source 108 and game frame 110 and one or more distribution interfaces 112 and 114, all of which are connected by links 140 to packet switch 120. Program library 105 is a high-capacity, long-term source of stored program material for data cache 104. Broadcast source 108 furnishes digitized and compressed program material from television broadcasts, cable systems, satellites or other means. In an exemplary embodiment, packet network 10 is an asynchronous transfer mode (ATM) network, links 140 are SONET OC-3 links, and packet switch 120 is an ATM switch such as the AT&T GCNS-2000 ATM switch.

In general, control processor 101 serves to interact with users selecting any of the various interactive services that may be provided by the system of the invention, and application processor 102 controls the services themselves. Control processor 101 also assigns the resources necessary to provide a service to a user. Application processor 102 and application resources such as data cache 104, multimedia frame 106, broadcast source 108 and game frame 110 can be duplicated as necessary to meet the capacity requirements of the system, but control processor 101 is preferably not duplicated because such processor maintains assignment records for the various resources in the system and making such records available to more than one processor, while achievable, is cumbersome. However, these task assignments to control processor 101 and application processor 102 are not inviolate, for example, in some applications it may be desirable to combine the functions of both proces-

sors in a single processor, or to use control processor 101 for certain applications.

Data cache 104 is a large random access memory for storing audio and video material in compressed and packetized form, such as the program server described in our copending patent application Serial No. 07/997,985 filed December 29, 1992. Data cache 104 can have one or more links 140 into packet network 10 depending on capacity requirements. Program library 105 can be a large-capacity system of any convenient type for storing program material, such as movies, musical selections, video clips, still frames and audio clips, in digitized and compressed form on devices such as magnetic tapes or optical discs and the like. Link 142 between program library 105 and data cache 104 can also be made via a separate ATM packet network, such as a SONET OC-3 network, or via packet network 10, depending on capacity and geographic limitations. Program library 105 is typically equipped to transmit a large quantity of data, such as digitized and compressed video and audio signals for complete movies, to data cache 104 in a relatively short time, as described in more detail in our above mentioned application.

It is contemplated that the various elements shown in FIG. 1 can be situated at different geographic locations. For example, packet switch 120, control processor 100, application processor 102, multimedia frame 106, broadcast source 108 and game frame 110 can be at a first location, data cache 104 can be at a second location and program library 105 can be at a third location. Other packet switches 120 and distribution interfaces such as 112 and 114 can be at still other locations. Connections between locations are SONET OC-3 links. It will be clear to those skilled in the art that numerous possible combinations of and locations for such elements are possible without departing from the spirit and scope of the invention.

Many interactive television services may be offered that incorporate broadcast television programs. Therefore, one of the application resources provided in the system of the invention can be a source of such programs, such as broadcast source 108, which receives one or more broadcast television signals from regular broadcasts, from satellite transmissions, from cable television systems or from any other appropriate means, all symbolized by antenna 109. Broadcast TV source 108 includes facilities for digitizing and compressing each received television signal and transmitting such signals in packetized form via packet network 10.

Multimedia frame 106 contains a number of units for composing compressed and packetized multimedia signals from a number of different sources, such as data cache 104, broadcast source 108 and internal text generators. Each such source typically provides a signal in digitized and compressed form. When a multimedia signal composed from multiple video

and/or audio sources is to be transmitted to a user, one of such composing units is assigned to create the multimedia signal. Note that the input signals to multimedia frame 106, as well as output signals to users, are all transmitted in packetized form through packet network 10. A system that can be used for multimedia frame 106 is described in copending patent application serial number filed (D. E. Blahut 34).

Game frame 110 contains a number of units for generating compressed and packetized audio and video signals for use in computer games that may be offered as part of an interactive television service. One such unit is assigned to each user of a computer game.

Application processor 102 and applications resources 104, 106, 108 and 110 can be used together in various ways to form what can be thought of as application servers for providing different ITV services. For example, a video-on-demand / enhanced-pay-per-view server could include application processor 102 and data cache 104; a multimedia ITV server could include application processor 102, data cache 104, multimedia frame 106 and broadcast source 108 and a game server could include application processor 102, multimedia frame 106 and game frame 110. Each application processor 102 can be used in more than one such server, up to the limit of its capacity.

Interfaces such as cable distribution interface 112 are typically located at cable television system headends and connected to signal converters 130 situated on cable customers' premises by distribution cable 116, whereby the signal converter 130 for each cable customer receives the same overall "downstream" signals broadcast to all cable customers served by the same cable distribution interface 112. However, as will be described, signal converters 130 can be enabled by control packets transmitted over cable 116 to receive only certain specified "virtual" channels from cable 116.

Interfaces such as telephone distribution interface 114 are typically located at telephone central offices and connected to signal converters 150 situated on telephone subscribers' premises by subscriber loops 118, whereby each telephone subscriber receives a different downstream signal. As will be described, signal converters 130 and 150 are configured for a cable customer and telephone subscriber, respectively.

Signal converters 130 and 150 convert the downstream signals into conventional television signals for display on television receivers 134. Users can send "upstream" signals to control processor 100 and applications processors 102 from input means such as remote control 132 that transmit control messages to signal converters 130 or 150, as the case may be. Other devices, such as processors, printers, video cameras, telephones and other input and output devices can be connected to signal converters 130 and

150 as required for the provision of ITV services.

The various data and control packets transmitted through packet network 10 each contain a header and a body. The header defines a "virtual channel" in which the packet is deemed to be transmitted. In data packets, the body contains data, such as part of a digitized and compressed audio or video signal. In control packets, the body contains information such as the address of the unit for which the packet is intended and an action to be performed. In the exemplary embodiment, each packet contains five bytes in the header and 48 bytes in the body. The header can include information such as polling addresses or virtual channel identities. Control packets are typically sent in one or more specifically assigned virtual channels, for example, channel "0."

Packet switch control 121 stores information specifying how to route packets arriving over links 140. Routing can be based on header contents; for example, certain virtual channels and/or certain polling addresses can be identified for transmission over a link. A packet arriving at packet switch 120 over any link 140 is then routed to one or more other links 140 depending on its header contents. Packet switch control 121 can itself receive packets from packet network 10, and, in the system of the invention, control processor 100 sends control packets as needed to packet switch control 121 containing such routing information.

In the exemplary embodiment, a television signal is made up of three separate data signals, one video and two audio (for stereophonic sound). Each signal is separately digitized and compressed and sent through packet network 120 as a packet stream in a separate virtual channel. Accordingly, three virtual channels are used for transmission of a single television signal. However, other embodiments are possible in which multiple audio channels are encoded and compressed together, such as the Dolby AC-2 system.

FIG. 2 shows typical flows of data and control packets through packet network 10 and in other parts of the system. During the furnishing of ITV services, data packets containing audio and/or video information flow from application resources such as data cache 104, multimedia frame 106 and game frame 110 to signal converters 130 and 150. Such data packets can also flow between application resources, such as from data cache 104 to multimedia frame 106 and game frame 110 and from broadcast source 108 to multimedia frame 106. During interactions with users, control packets flow between signal converters 130 and 150 and control processor 100 and/or between signal converters 130 and 150 and application processor 102. Control processor 100 interacts with application processor 102 and with packet switch control 121 by means of control packets, and application processor 102 interacts with application re-

sources 104, 105, 106, 108 and 110 by means of control packets. Data packets from program library 105 to data cache 104 can be sent via a direct link or via a packet network; even via packet network 10, if convenient. The link between application processor 102 and program library 105 carries only control packets and can be of lower capacity than links 140, for example, such link can be part of an Ethernet (tm) network. However, such link can also be a low-bandwidth virtual channel in packet network 10, if desired.

The flexibility of packet network 10 makes possible flows of data and control packets between any pair of terminals and from one terminal to groups of terminals. Possibly useful paths for control packets that are not shown are between signal converters 130 and 150 on the one hand to multimedia frame 106 and game frame 110 on the other. These paths may be desirable for use in time-dependent interactive applications using multimedia frame 106 and game frame 110 in which an extremely fast response to an action by a user is desired. Multimedia frame 106 and game frame 110 will typically include processors that can generate and respond to such control packets. Similarly, if control processor 100 also performs the functions of application processor 102, paths for control packets will be needed from control processor 100 to the various resources 102, 104, 105, 106, 108 and 110.

In general, control processor 100 interacts with users to control requested services and to assign the various resources needed to furnish the services, including the necessary virtual channels in packet network 10 and the various other links in the system. During the delivery of a service by application resources 104, 106 and 110, under control of application processor 102, control processor 100 maintains supervision by responding to certain control packets from signal converters 130 and 150; application processor 102 responds to control packets from signal converters 130 and 150 specifically relating to an ITV service being delivered. However, as described above, application resources may be equipped to respond directly to control packets from signal converters 130 and 150.

FIG. 3 is a block diagram of interface 112 for use at a cable television system headend for distributing integrated television services over a cable system in accordance with the invention. ATM interface 310 receives packets from packet network 10 over link 140, forwards data packets to downstream demultiplexer (DEMUX) 312 and forwards control packets addressed (in the body) to control 314. Certain types of control packets set up interface 310 to transmit packets over the various cable feeders originating at the headend, for example, feeders 350 and 352, based on the header contents of the packets. Thus, interface 112 also acts as a packet router or switch. Demultiplexer 312 routes all the data and control packets for

5 a particular cable feeder to a downstream RF modulator, such as modulator 316 for feeder 350 and modulator 318 for feeder 352. Such control packets can, for example, include a converter address and information on virtual channels from which such converter is to receive packets containing audio and video data. These RF modulators convert the digital bit streams from demultiplexer 312 to modulated signals for transmission over one or more of the standard distribution channels (typically 6 mHz wide) in the cable system. Such modulation can be, for example, quadrature amplitude modulation such as 64 QAM. Other programs from standard cable program sources are modulated onto other channels and sent over other distribution channels in the cable system by amplifiers 330, as is well known in the art.

10 Control packets from signal converters 130 situated at cable customer locations are received by upstream RF demodulators such as demodulators 320 and 322. Such signals are typically sent in the 5-30 MHz band. Upstream multiplexer (MUX) 324 converts the bit streams from the various demodulators into appropriate virtual channels for transmission over packet network 10 via ATM interface 310. For example, control packets relating to particular ITV services can be assigned to a particular virtual channel assigned to such service and routed to the appropriate destination for such service.

15 FIG. 4 is a block diagram of a signal converter 130 for use at the premises of a cable customer receiving ITV services. A similar converter having additional features is described in copending application Serial No. 07/965,492, filed October 23, 1992. Input cable 402 is typically a coaxial cable or an optical fiber cable connected to the cable distribution system. Cable 402 is connected to inputs of band-stop filter 404 and ITV channel receiver 408 and to the output of uplink modulator 410. Cable 402 is part of an input circuit (not shown), that also contains any interface apparatus, such as optical/electrical transducers and amplification and buffering circuits needed to connect the cable system to filter 404, receiver 408 and modulator 410. Such interface apparatus and amplification and buffering circuits are well known to those skilled in the art.

20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 1240 1245 1250 1255 1260 1265 1270 1275 1280 1285 1290 1295 1300 1305 1310 1315 1320 1325 1330 1335 1340 1345 1350 1355 1360 1365 1370 1375 1380 1385 1390 1395 1400 1405 1410 1415 1420 1425 1430 1435 1440 1445 1450 1455 1460 1465 1470 1475 1480 1485 1490 1495 1500 1505 1510 1515 1520 1525 1530 1535 1540 1545 1550 1555 1560 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730 1735 1740 1745 1750 1755 1760 1765 1770 1775 1780 1785 1790 1795 1800 1805 1810 1815 1820 1825 1830 1835 1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115 2120 2125 2130 2135 2140 2145 2150 2155 2160 2165 2170 2175 2180 2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3205 3210 3215 3220 3225 3230 3235 3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 4240 4245 4250 4255 4260 4265 4270 4275 4280 4285 4290 4295 4300 4305 4310 4315 4320 4325 4330 4335 4340 4345 4350 4355 4360 4365 4370 4375 4380 4385 4390 4395 4400 4405 4410 4415 4420 4425 4430 4435 4440 4445 4450 4455 4460 4465 4470 4475 4480 4485 4490 4495 4500 4505 4510 4515 4520 4525 4530 4535 4540 4545 4550 4555 4560 4565 4570 4575 4580 4585 4590 4595 4600 4605 4610 4615 4620 4625 4630 4635 4640 4645 4650 4655 4660 4665 4670 4675 4680 4685 4690 4695 4700 4705 4710 4715 4720 4725 4730 4735 4740 4745 4750 4755 4760 4765 4770 4775 4780 4785 4790 4795 4800 4805 4810 4815 4820 4825 4830 4835 4840 4845 4850 4855 4860 4865 4870 4875 4880 4885 4890 4895 4900 4905 4910 4915 4920 4925 4930 4935 4940 4945 4950 4955 4960 4965 4970 4975 4980 4985 4990 4995 5000 5005 5010 5015 5020 5025 5030 5035 5040 5045 5050 5055 5060 5065 5070 5075 5080 5085 5090 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150 5155 5160 5165 5170 5175 5180 5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 6225 6230 6235 6240 6245 6250 6255 6260 6265 6270 6275 6280 6285 6290 6295 6300 6305 6310 6315 6320 6325 6330 6335 6340 6345 6350 6355 6360 6365 6370 6375 6380 6385 6390 6395 6400 6405 6410 6415 6420 6425 6430 6435 6440 6445 6450 6455 6460 6465 6470 6475 6480 6485 6490 6495 6500 6505 6510 6515 6520 6525 6530 6535 6540 6545 6550 6555 6560 6565 6570 6575 6580 6585 6590 6595 6600 6605 6610 6615 6620 6625 6630 6635 6640 6645 6650 6655 6660 6665 6670 6675 6680 6685 6690 6695 6700 6705 6710 6715 6720 6725 6730 6735 6740 6745 6750 6755 6760 6765 6770 6775 6780 6785 6790 6795 6800 6805 6810 6815 6820 6825 6830 6835 6840 6845 6850 6855 6860 6865 6870 6875 6880 6885 6890 6895 6900 6905 6910 6915 6920 6925 6930 6935 6940 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995 7000 7005 7010 7015 7020 7025 7030 7035 7040 7045 7050 7055 7060 7065 7070 7075 7080 7085 7090 7095 7100 7105 7110 7115 7120 7125 7130 7135 7140 7145 7150 7155 7160 7165 7170 7175 7180 7185 7190 7195 7200 7205 7210 7215 7220 7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 8235 8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915 9920 9925 9930 9935 9940 9945 9950 9955 9960 9965 9970 9975 9980 9985 9990 9995 9999 10000 10005 10010 10015 10020 10025 10030 10

which is forwarded to controller 414.

Controller 414 performs many functions and is typically a microprocessor with both random-access memory (RAM) and read-only memory (ROM). Controller 414 sends control messages to receiver 408 specifying the identity of the cable channel to be received, receives manual inputs from manual input devices 418, sends video packets to decoder 415 and audio packets to decoder 416 and transmits information to the cable headend via uplink modulator 410. Depending on the audio encoding standard used, an audio packet can contain information for more than one audio channel. Examples of input devices 418 are keyboards, handheld "mice" for use with video displays and infrared remote control devices, such as those used with television receivers and recorders, as indicated at 132 in FIG. 1.

Decoders 415 and 416 can also be microprocessors, such as digital signal processors, specifically programmed to decode compressed video or audio information, as the case may be, in accordance with the appropriate decoding algorithm, as is well known in the art. Other output devices 420 capable of receiving digital information, such as a printer, can be connected to controller 414 as desired.

Band stop filter 404 deletes at least one of the ITV channels, preferably the default channel, from the signal received from cable 402, passing the remaining channels to output cable 430. Modulator 422 modulates the television signal received from video decoder 415 and audio decoder 416 into one of the blocked ITV channels on output cable 430. Thus, converter 130 replaces the packetized digital signal received from the cable system in such ITV channel with the television signal from decoders 415 and 416. Such ITV channel can then be selected and viewed in the conventional way on a cable-ready television receiver connected to output cable 430. As described above, the television signal modulated into such ITV channel can be produced from ITV packets received over any of the ITV channels.

For applications in which audio programs are transmitted over an ITV channel, a separate audio output can be provided, as shown at 440, which can be used by equipment such as a high-fidelity sound system. Such audio output can have more than one channel, if desired.

As mentioned above, each packet received in an ITV cable channel contains identification of a virtual channel. Program information can be "multicast" on virtual channels for receipt by one or more subscribers. As also mentioned above, control messages are sent over at least one of the virtual channels not being used for program information. Different types of programs can be transmitted in each virtual channel, for example full motion video, still pictures, audio or text. When converter 130 is to receive a program from a virtual channel, a control message addressed to con-

verter 130 causes controller 414 to store the identification of such virtual channel. Thereafter, controller 414 processes the contents of each packet identified as part of such virtual channel. Moreover, controller 414 can be set to process information in more than one virtual channel, if desired. For example, the audio and video portions of a movie can be sent simultaneously on different virtual channels, possibly with soundtracks in different languages on different channels.

FIG. 5 is a block diagram of an interface 114 for distributing integrated television services over a telephone network. ATM interface 510 receives packets from packet network 10 and forwards data packets intended for distribution by the interface to concentrator 512 and control packets intended for interface 114 to control 514. Certain control packets are used to set up concentrator 512 through control 514 to transmit specific virtual channels received from packet network 10 to each telephone subscriber via line cards 516 and telephone subscriber loops 518. Typically, a line card 516 is used for each telephone subscriber loop 518 over which interactive television services are to be provided and subscriber loop 518 is connected to both such line card and also to central office switch 520 for the provision of ordinary telephone service. Concentrator 512 demultiplexes and routes downstream packets from interface 510 to the appropriate line cards 516 and multiplexes upstream packets from line cards 516 for placement onto packet network 10 via ATM interface 510. Each line card 516 applies the downstream packets from concentrator 512 onto a telephone circuit 518 and retrieves upstream digital signals from telephone circuit 518 for multiplexing onto packet network 120 by concentrator 512.

Subscriber loops 518 are adapted for transmission of both ordinary telephone signals and the upstream and downstream control and data packets described above. Such a loop is sometimes called an asymmetric digital subscriber loop because the digital bandwidth toward the subscriber is much greater than the digital bandwidth away from the subscriber. The digital signals comprising the control and data packets can be transmitted in a mode known as "data over voice" in which the digital bandwidth is positioned to leave room at the lower end of the frequency spectrum for insertion of a voice signal for ordinary telephone service. Alternatively, the voice signal can also be digitized and sent as packets. Some of these techniques are described in U.S. Patent No. 4,924,492 to Gitlin et al.

FIG. 6 is a block diagram of a signal converter 150 for use at the premises of a customer receiving ITV services over a telephone subscriber loop. Subscriber loop interface 652 is connected to subscriber loop 518 and retrieves the digital signal comprising the control and data packets transmitted by line card 516. Controller 656, which can be a microprocessor,

routes video data packets to digital decoder 658 and audio data packets to audio decoder 660. Channel modulator 662 generates a conventional television signal from the outputs of decoders 658 and 660 and sends such television signal to the user's television receiver via lead 664. The subscriber's telephone 654 is also connected to interface 652.

Manual input devices 670 and output devices 672 are also connected to controller 656 as described for corresponding elements 418 and 420 in FIG. 4. On receipt of inputs from input devices 670, controller 656 generates appropriate control packets for transmission over subscriber loop 518 via subscriber loop interface 652.

FIG. 7 is a diagram of an example of a menu screen 700 for use in interactions with users of the system of the invention. Such a menu screen can be displayed to a user first gaining access to the system on the user's television set, and is an example of a multimedia program composed in multimedia frame 106 (FIG. 1). Menu screen 700 consists of three scaled-down full-motion video images 720, 730 and 740 displayed in window overlays on a still-frame background 710 and with superimposed text 750. Display of such a screen is typically accompanied by appropriate background audio, such as a stereophonic musical selection.

Control processor 100 typically controls transmission of a menu screen, such as menu screen 700, to signal converters 130 and 150 for users not currently using ITV services (inactive users) and monitors uplink messages from such signal converters. The menu screen is somewhat analogous to dial tone in a telephone system, and can be "broadcast" to multiple users by transmitting the audio and video portions of the screen over dedicated virtual channels in packet network 10 and enabling signal converters 130 for idle cable-customer users (and concentrator 512 for idle telephone-subscriber users) to receive such dedicated virtual channels. However, there can be multiple menu screens for different groups of users who, for example, subscribe to different packages of interactive television services.

To generate menu screen 700, application processor 102 assigns a composing unit in multimedia frame 106 and control processor 100 assigns virtual channels in packet network 10 for routing the appropriate audio and video signals for the elements in the menu screen, in digitized and compressed form, to multimedia frame 106 and such composing unit. The full-motion video packets for the movie excerpt to be shown in window 720 and the game teaser to be shown in window 740 and audio packets for the background audio are stored in data cache 104. The video signal for the shopping channel to be shown in window 730 is supplied by broadcast source 108. The still-frame background is stored and the text is generated in the composing unit. Thus, four virtual chan-

nels through packet switch 10 from data cache 104 to multimedia frame 106 are needed for the current-movie video, the game-teaser video and the stereophonic background audio; one virtual channel from broadcast source 108 to multimedia frame 106 is needed for the shopping channel video and three virtual channels are needed from multimedia frame 106 to distribution interfaces 112 and/or 114 are needed for the multimedia signal (one video, two audio) for the menu screen itself.

In order to more fully explain the operation of the system of the invention, reference will be made to the flow chart of FIG. 8, which represent an interaction in which a cable-customer user requests a movie from a video-on-demand service and the movie is presented using apparatus as shown in FIG. 1. In the numbered steps shown in FIG. 8, a "C" indicates that control processor 100 controls the step and an "A" indicates that application processor 102 controls the step.

Referring now to FIG. 8, control processor 100 causes a menu, such as menu screen 700, to be received by signal converters 130 and 150 of all inactive users (step 800). A user requests a particular ITV function by first selecting the channel on which the ITV service is furnished, which causes the main menu to appear on the user's television set (step 802). Then, using an input device such as remote control 132, the user selects the "Movie" category (step 804). This causes signal converter 130 to transmit a control packet addressed to control processor 100 indicating the type of ITV service requested. Control processor 100 then assigns virtual channels for transmission of the movie to the requesting user and initiates a movie selection process in application processor 102 for the user. The movie selection process causes one or more menu screens for movie selection (which can be created in multimedia frame 106) to be transmitted to the requesting user (step 806). Control packets from the user are directed to application processor 102 during the selection process. When the user selects a movie (step 808), application processor 102 determines whether the movie is stored in data cache 104 (step 810). If not, then application processor 102 causes program library 105 to download the movie (at high speed) to data cache 104 (step 812).

As described in our above mentioned application, various audio/video materials are stored in a large random-access memory, such as data cache 104, in compressed and packetized form and retrieved for a given user by referring to a pointer or pointers associated with that user. Commands from the user can modify the pointers; thus, the user can request actions such as pause, rewind, fast forward and the like. Such commands entered by the viewer on an input device such as remote control 132 are sent by signal converter 130 or 150 to application processor 102 in

the form of control packets. Application processor 102 then forwards the appropriate control packets to data cache 104 to cause the requested action.

When application processor 102 confirms that the requested movie is stored in data cache 104, a display process is initiated in application processor 102 that causes the movie to be transmitted from data cache 104 to the user over the assigned virtual channels and interacts with the viewer and data cache 104 by means of control packets to control the showing. When the showing is finished, the associated process in application processor 102 terminates and control for such user reverts to control processor 100, thereby causing the user to again receive the main menu (step 816). Control processor 100 can then reassign the virtual channels assigned to showing the movie for other purposes.

Other important activities to be performed in the ITV system of the invention include maintaining records such as customer profiles specifying the services that individual users are authorized to receive and, for billing purposes, activity records of services actually provided. Such record maintenance can be performed by application processor 102, control processor 100 and/or a separate billing processor (not shown) connected to packet network 10. Typically, customer profiles are maintained in control processor 100 and activity records in application processor 102. If a separate billing processor is used for customer accounts, application processor 102 can be configured to periodically transmit accounting data to the billing processor via packet network 10.

The invention has been shown and described with reference to particular embodiments. However, it will be understood by those skilled in the art that various changes may be made therein without departing from the spirit and scope of the invention.

## Claims

1. A system for delivering digital signals to users over at least one distribution system in response to digital commands received from said users over said distribution system, which comprises:
  - a digital network;
  - at least one means for transmitting said digital signals from said network to said distribution system and said digital commands from said distribution system to said network;
  - at least one means for applying said digital signals to said network;
  - control means connected to said network for interacting with said users, controlling said network and controlling said applying means by digital signals transmitted and received over said network.

2. The system of claim 1 in which said digital network comprises a packet network.
3. The system of claim 1 in which said distribution means comprises means for transmitting digital signals over a cable television network.
4. The system of claim 1 in which said distribution means comprises means for transmitting digital signals over telephone subscriber loops.
5. The system of claim 1 in which at least one of said applying means comprises memory means for storing audio and/or video signals in digital form.
6. The system of claim 5 in which said means for storing is a random access memory.
7. The system of claim 6 in which said random access memory comprises a data cache and said means for storing further comprises means connected to said data cache for long-term storage of audio and/or video signals in digital form.
8. The system of claim 1 in which at least one of said applying means comprises at least one means for composing audio and/or video signals for application to said network from at least one other audio and/or video signal received from said network.
9. The system of claim 8 in which said control means further comprises means for assigning each said composing means when a demand for one of said composing means arises.
10. The system of claim 1 in which at least one of said applying means comprises a source of broadcast audio and/or video signals in digital form.
11. The system of claim 1 in which said audio and/or video signals in digital form are compressed and in which said converting means further comprises:
  - means for decompressing said audio and/or video signals.
12. The system of claim 1 in which said control means is at least one processor connected to said digital network for sending control signals to other elements in said system through said control network.
13. A method of delivering digital signals from at least one source to at least one user in response to commands from said user, which comprises:
  - transmitting said commands to processing means;
  - at said processing means, transmitting

one or more control signals to said at least one source in accordance with said received commands;  
 at said source, transmitting said digital signals to said user in response to said control signals. 5

14. The method of claim 13 which further comprises:  
 transmitting said commands, said control signals and said digital signals in the form of digital packets. 10

15. The method of claim 13 wherein said digital signals represent audio and/or video signals, which further comprises:  
 for each user, converting said digital signals received from said source to audio and/or video signals. 15

16. The method of claim 13 wherein at least one of said digital signals delivered to a user is a combined digital signal made up of multiple component digital signals, which further comprises:  
 transmitting said component digital signals from multiple ones of said sources to combining means;  
 at said combining means, combining said component digital signals to form said combined digital signal and transmitting said combined digital signal to said user. 20

17. The method of claim 16 wherein said combined signal is a multimedia signal and said component signals are video and/or audio signals in digital form. 25

18. The method of claim 13 wherein a digital signal from one of said sources is transmitted to multiple users, which further comprises:  
 storing said given digital signal in said source and  
 retrieving said stored digital signal and transmitting said stored digital signal separately for each one of said multiple users. 30

19. Apparatus for delivering digital signals from at least one source to at least one user in response to commands from said user, which comprises:  
 means for transmitting said commands to processing means;  
 at said processing means, means for transmitting one or more control signals to said at least one source in accordance with said received commands;  
 at said source, means for transmitting said digital signals to said user in response to said control signals. 35

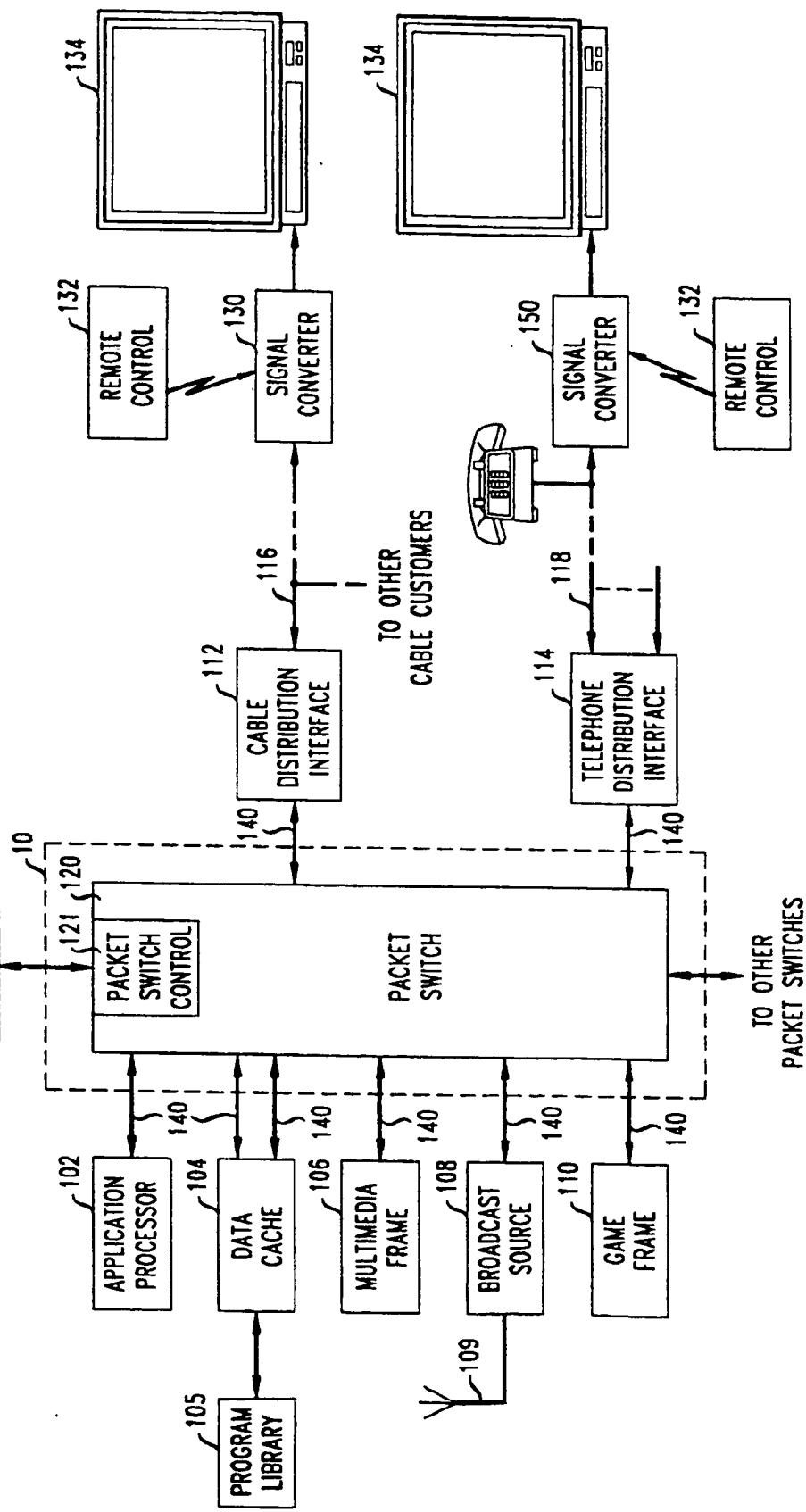
20. The apparatus of claim 19 which further comprises:  
 means for transmitting said commands, said control signals and said digital signals in the form of digital packets. 40

21. The apparatus of claim 19 wherein said digital signals represent audio and/or video signals, which further comprises:  
 for each user, means for converting said digital signals received from said source to audio and/or video signals. 45

22. The apparatus of claim 19 wherein at least one of said digital signals delivered to a user is a combined digital signal made up of multiple component digital signals, which further comprises:  
 means for combining said component digital signals to form said combined digital signal and transmitting said combined digital signal to said user. 50

55

FIG. 1



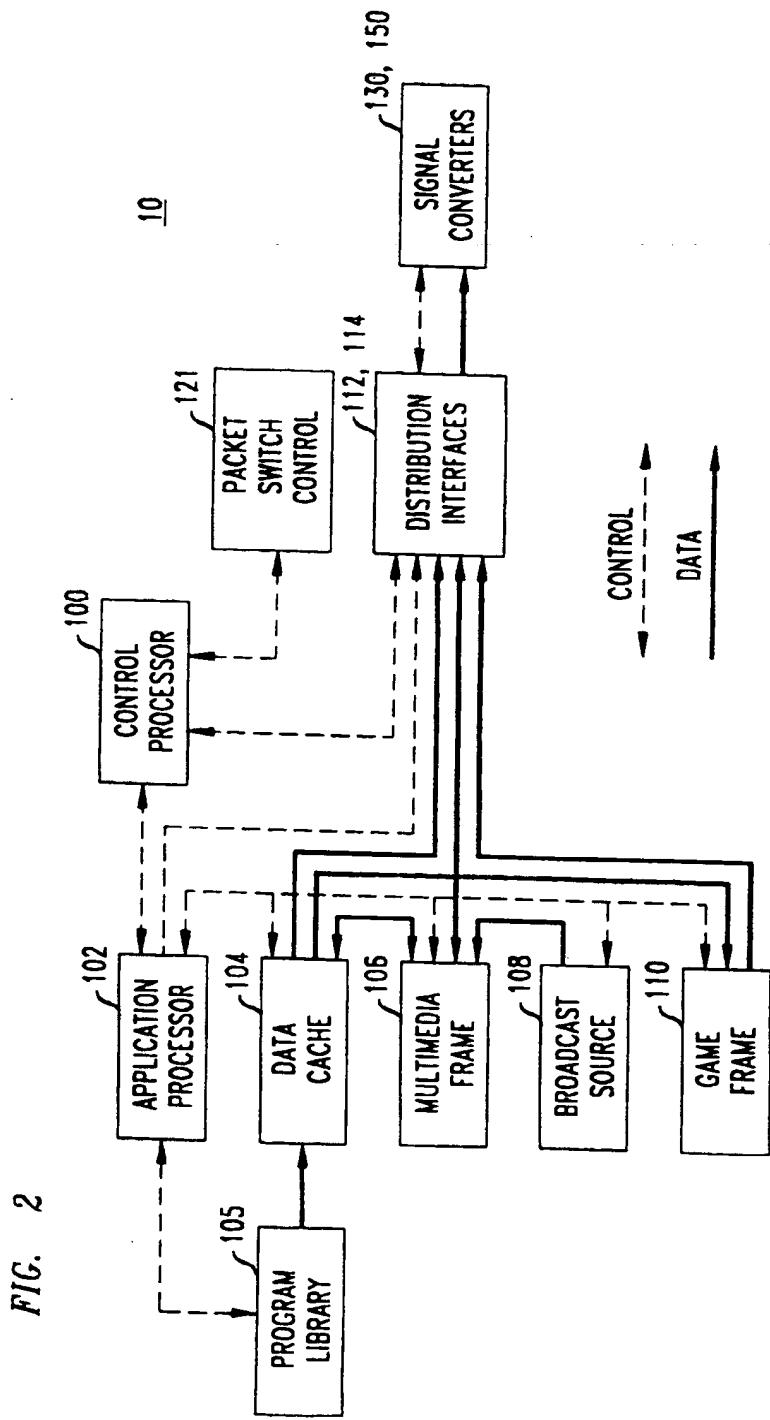


FIG. 3

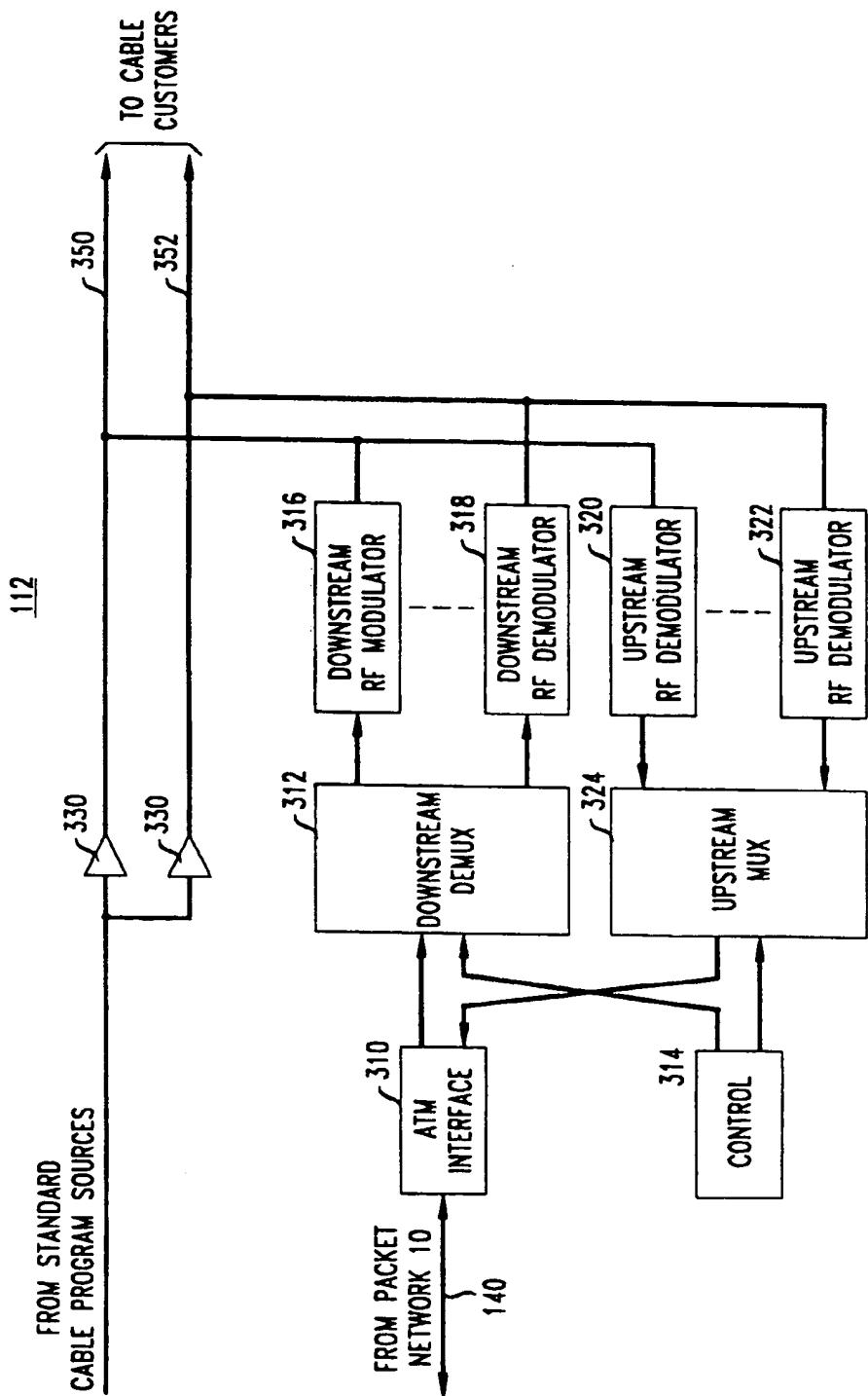


FIG. 4

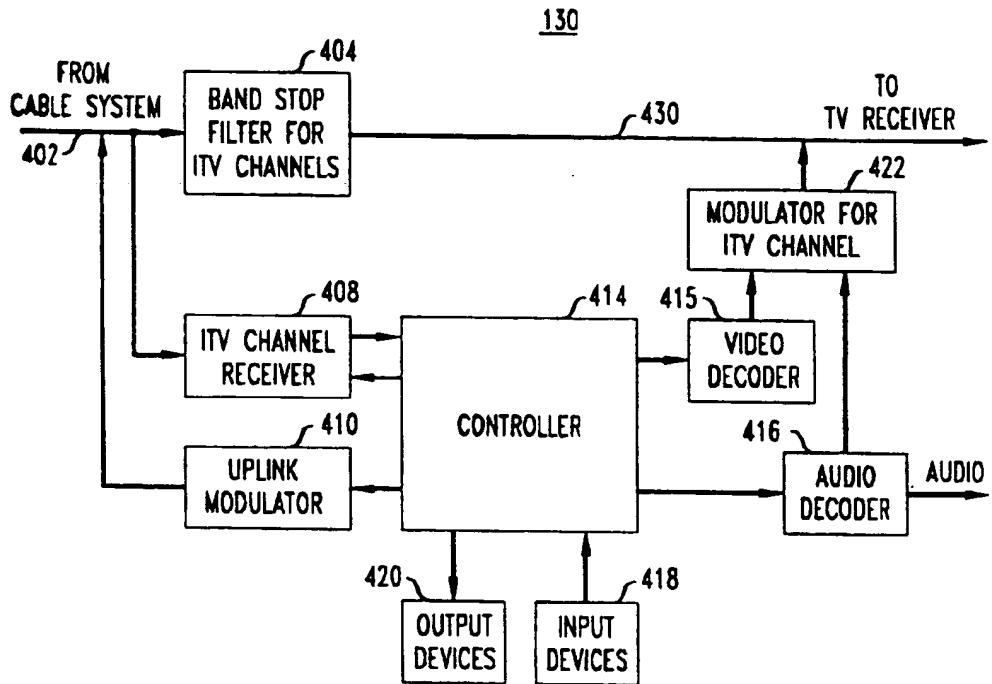


FIG. 5

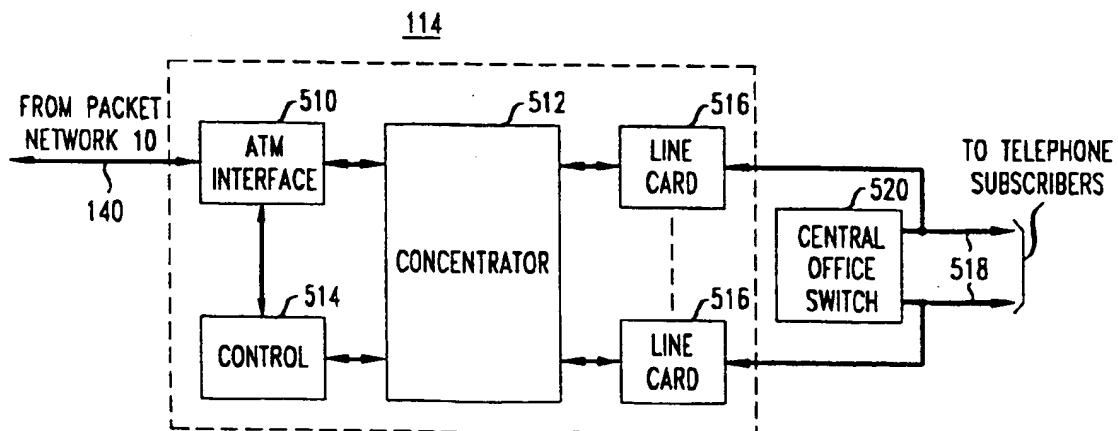


FIG. 6

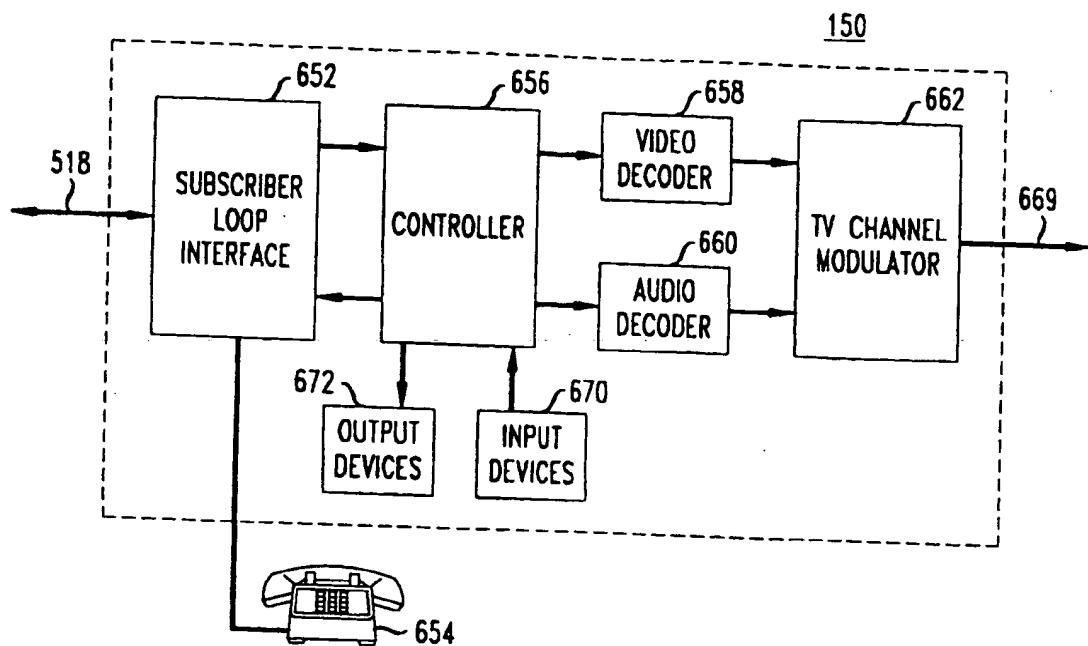


FIG. 7

710

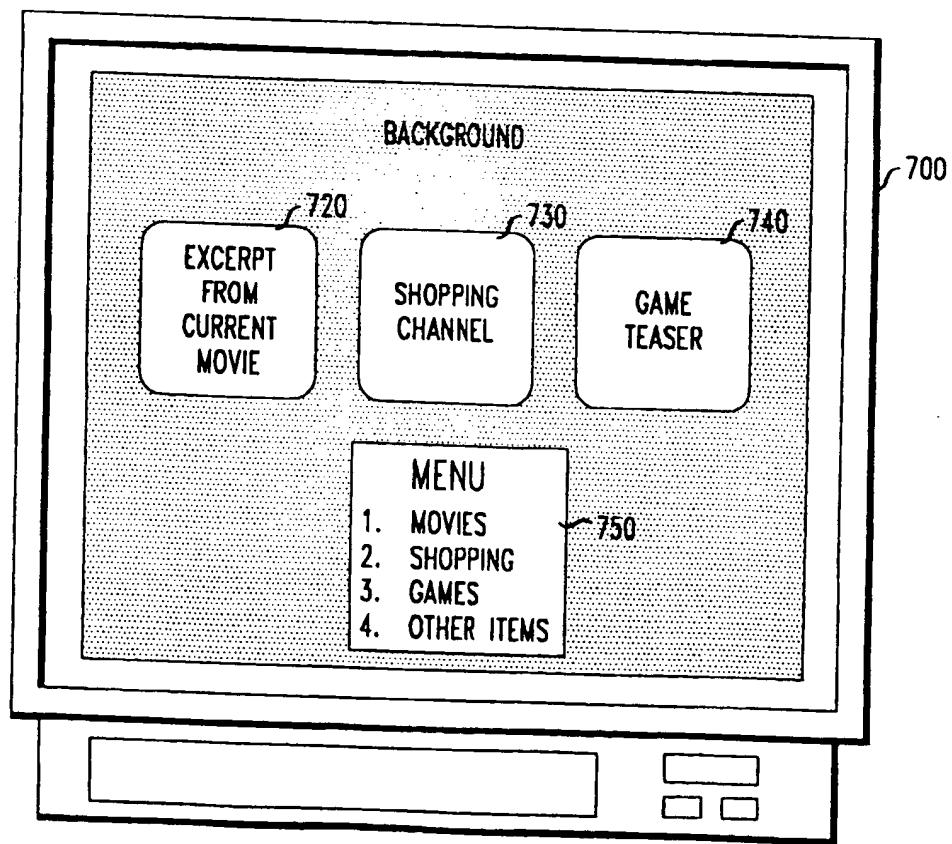


FIG. 8

